Estimating the Economic Impacts of Climate Change on California Agriculture

Richard Howitt, Josué Medellín-Azuara, Duncan MacEwan and Jay Lund

University of California, Davis

Overview

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- Model Innovations
  - Universal Innovations
  - Climate Change Innovations
- Results
  - Extensive Margin
    - Land Use, Prices, Revenues, Water Use
  - Intensive Margin
    - Water Use per Acre in Region 19
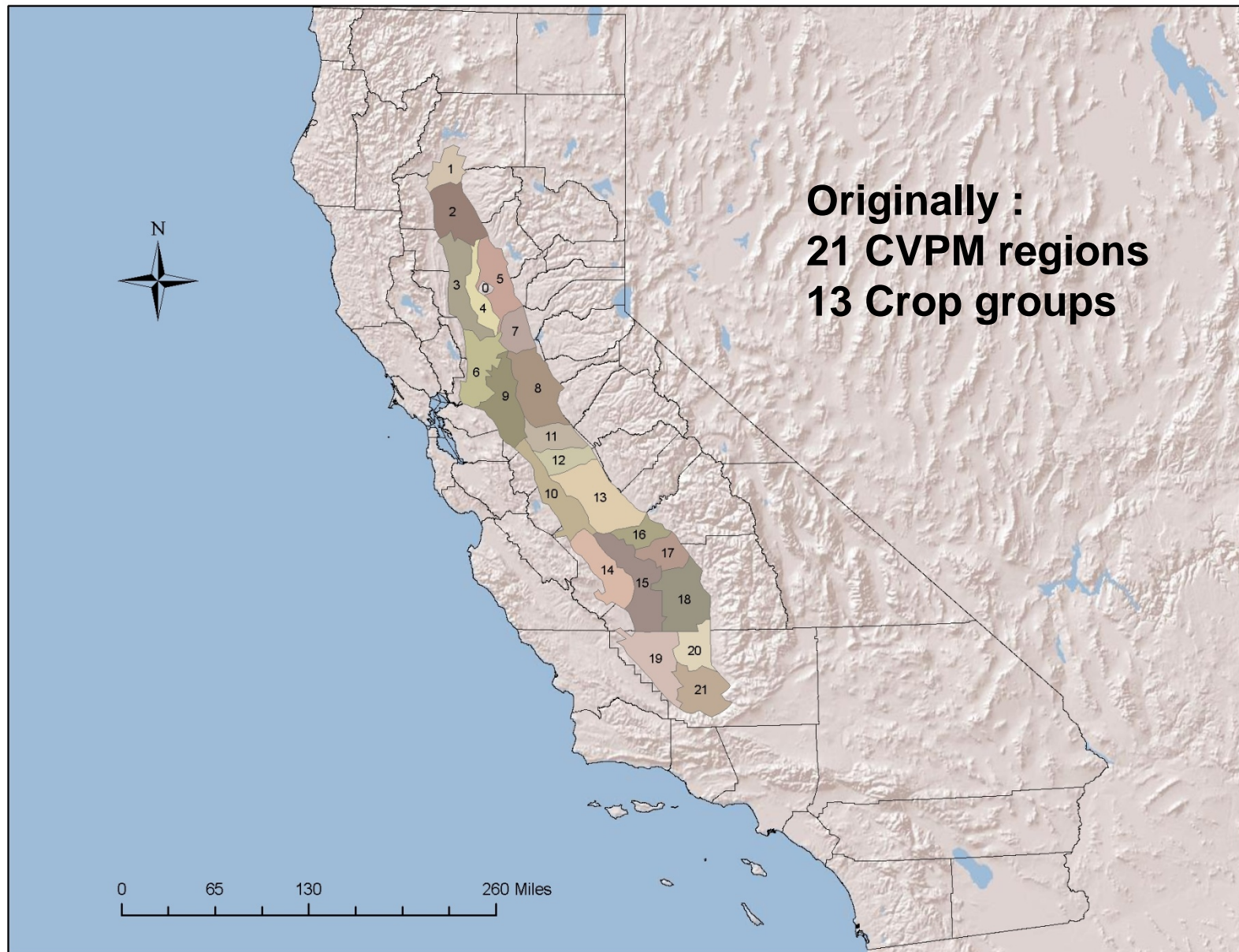- Extensions
- Conclusions

Introduction

- Value of Agriculture in California
- Land cropping patterns are influenced by
  - Economic factors
  - Geographic conditions
  - Climatic conditions
- Future of California agriculture
  - Interaction among:
    - Technology
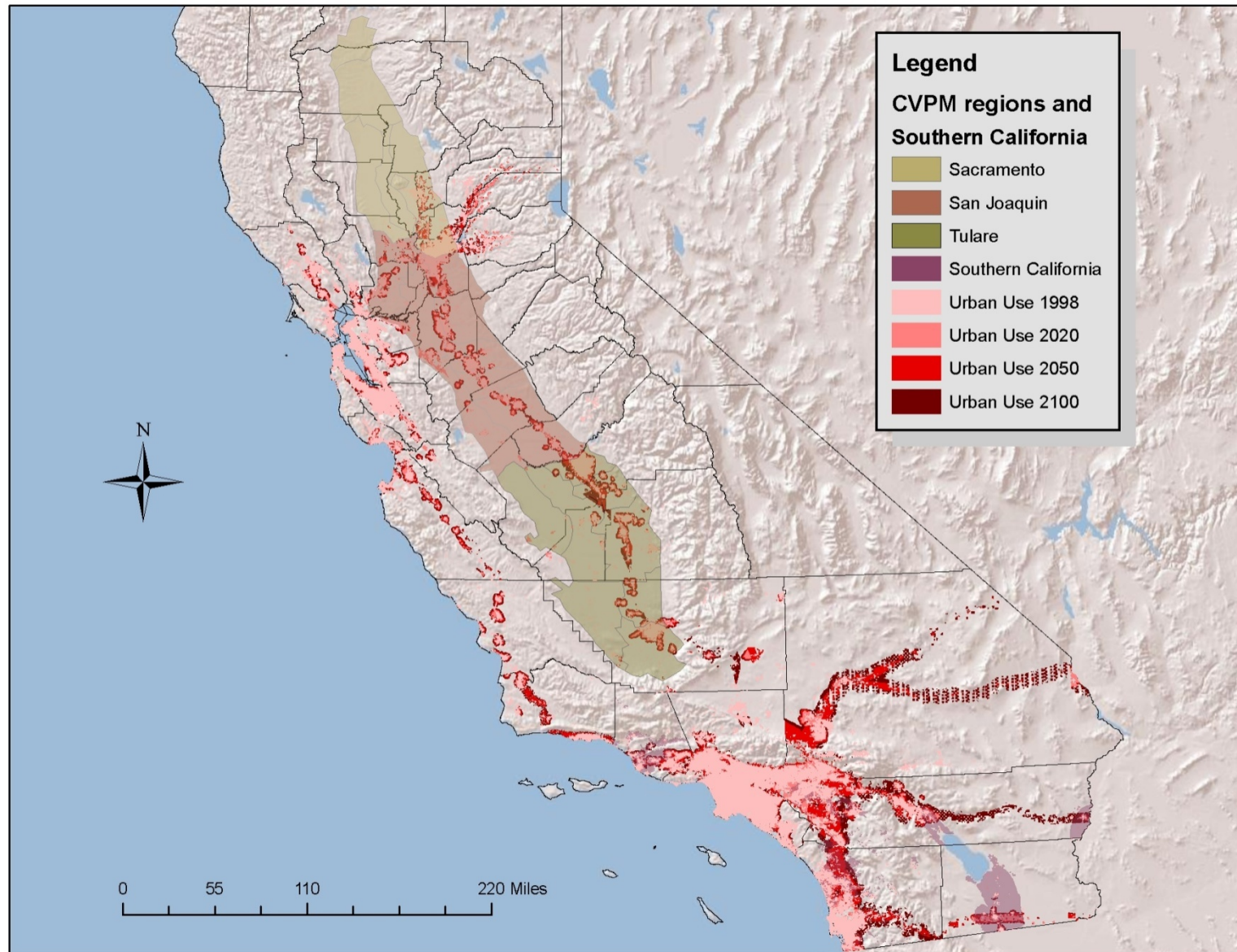   - Resources
    - Market demands

The Statewide Agricultural Production Model (SWAP)

- Farmers are assumed:
  - Rational
  - Aimed to maximize profits
- Three step self-calibrating PMP
- Dairy herd feed is included
- Inputs: water, labor, land, supplies, 2000-05
- Thirteen Crop groups
- Two climate scenarios analyzed 2050
  - Historical
  - Warm-Dry

SWAP Geographical Coverage

Originally :
21 CVPM regions
13 Crop groups

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Land Use Changes 2100

Legend

CVPM regions and Southern California

- Sacramento
- San Joaquin
- Tulare
- Southern California
- Urban Use 1998
- Urban Use 2020
- Urban Use 2050
- Urban Use 2100

N

0   55   110   220 Miles

Technological Change and Crop Demands by 2050

Crop	Yield % Change Technology	Demand % Change Intercept
Alfalfa*	29.1	3.3
Citrus	28.5	3.6
Corn	25.4	5.7
Cotton	29.1	2.1
Field	29.1	3.3
Grains	29.1	7.6
Grapes	23.4	16.4
Orchards	36.4	3.8
Rice	31.9	-4.1
Tomato	40.1	26.9
Truck	25.4	45.5

Climate Change Model Innovations

- Water Availability (feedback from CALVIN)

% Change in Available Water	Agriculture	Urban
Total	-25.7	-0.5

- Climate Induced Yield Change

Crop Groups	Sacramento	San Joaquin
Alfalfa	4.9	7.5
Citrus	1.77	-18.4
Corn	-2.7	-2.5
Cotton	0.0	-5.5
Field	-1.9	-3.7
Grain	-4.8	-1.4
Orchards	-9.0	-9.0
Pasture	5.0	5.0
Grape	-6.0	-6.0
Rice	0.8	-2.8
Tomato	2.4	1.1
Truck Crops	-11.0	-11.0

Extensive Margin Results: Land Use Changes

- Shift to less water intensive crops
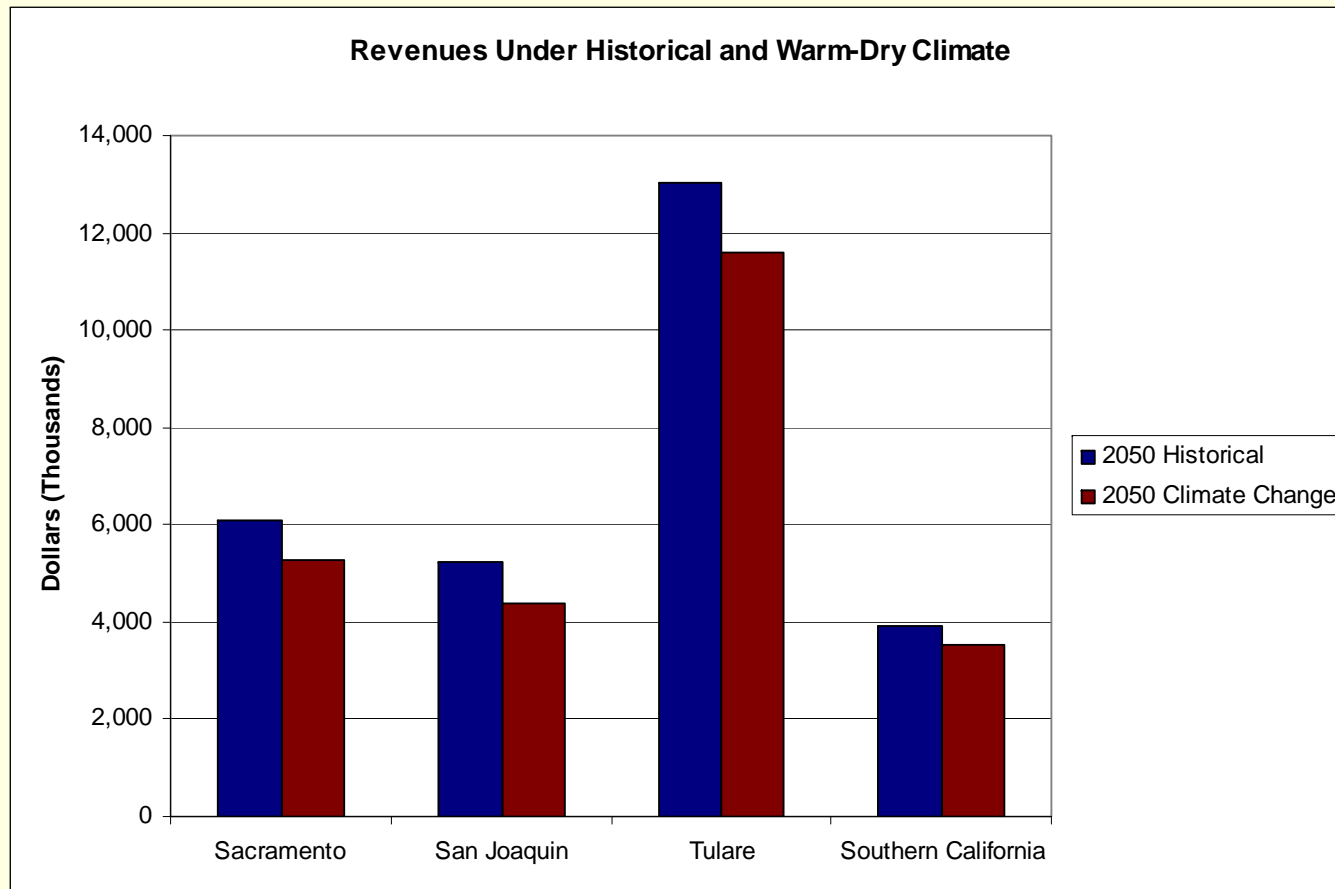- Production shifts to regions with comparative advantages
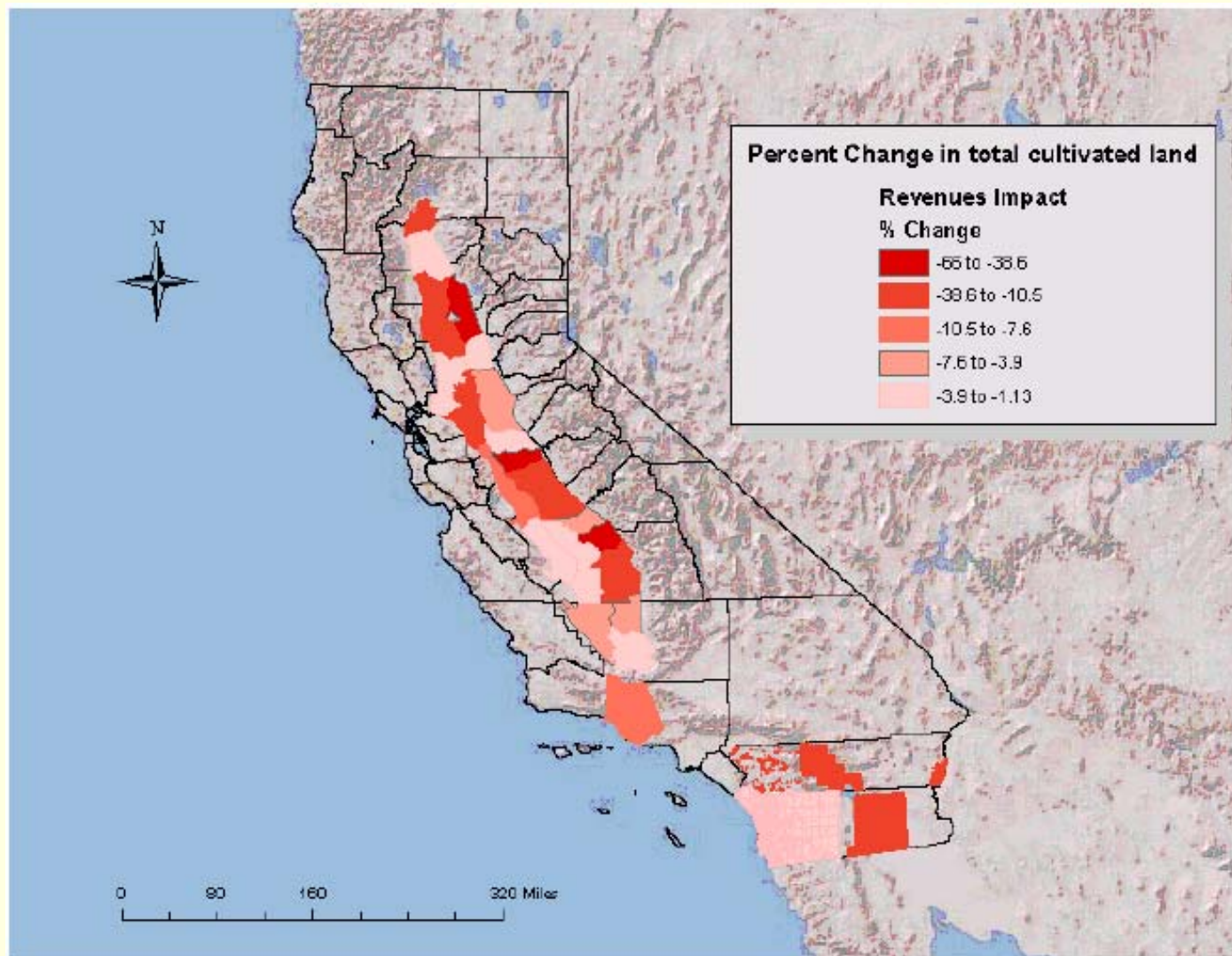

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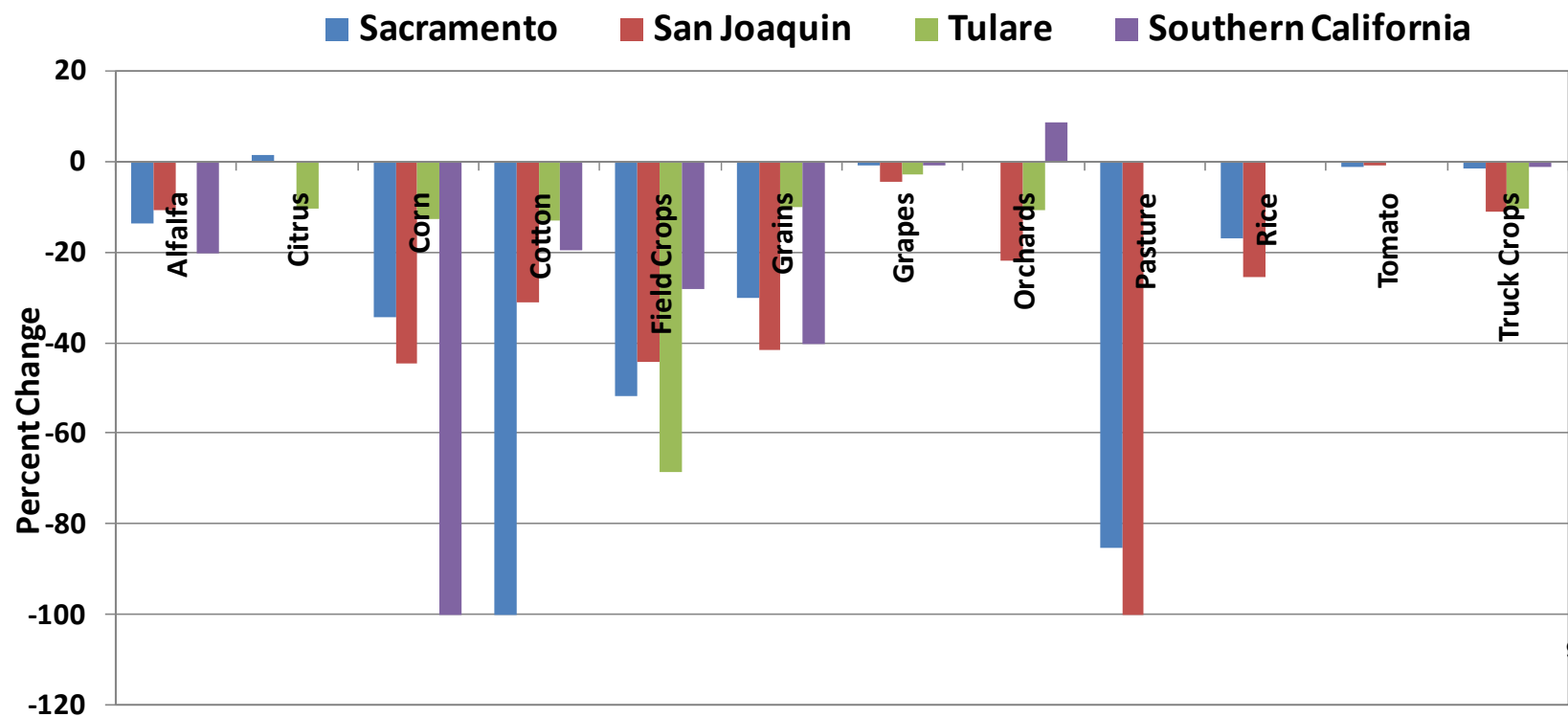
Land Use Changes with Climate Change
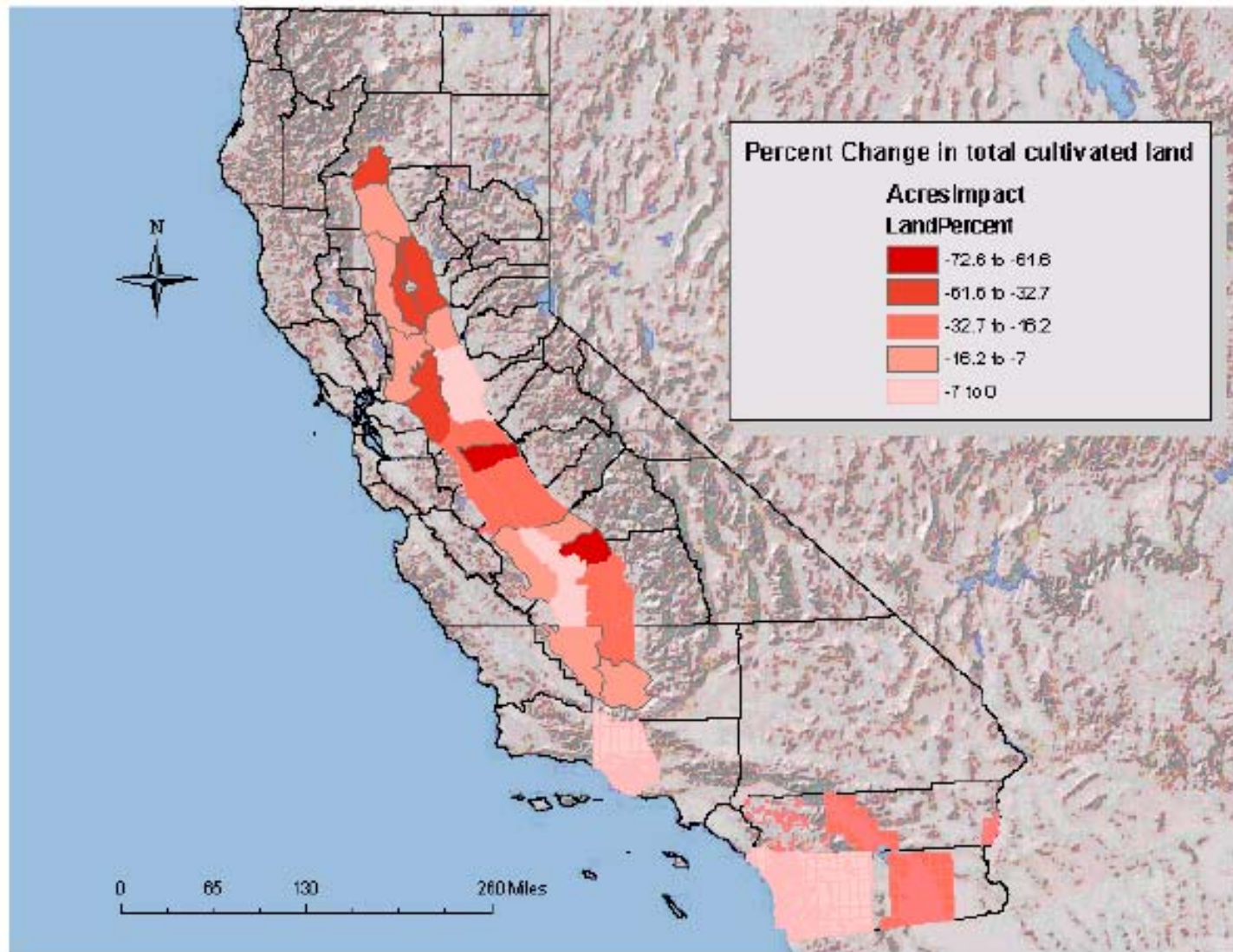
Extensive Margin Results: Regional Revenue

■ Revenues reductions across regions

Revenues Under Historical and Warm-Dry Climate

Legend:
■ 2050 Historical
■ 2050 Climate Change

Change in Revenues with Climate Change

Percent Change in total cultivated land

Revenues Impact

% Change
- -66 to -38.6
- -38.6 to -10.5
- -10.5 to -7.6
- -7.6 to -3.9
- -3.9 to -1.13

Extensive Margin Results:
Crop Prices, Production, Revenues

Price, Production, Revenue Percent Changes by Crop

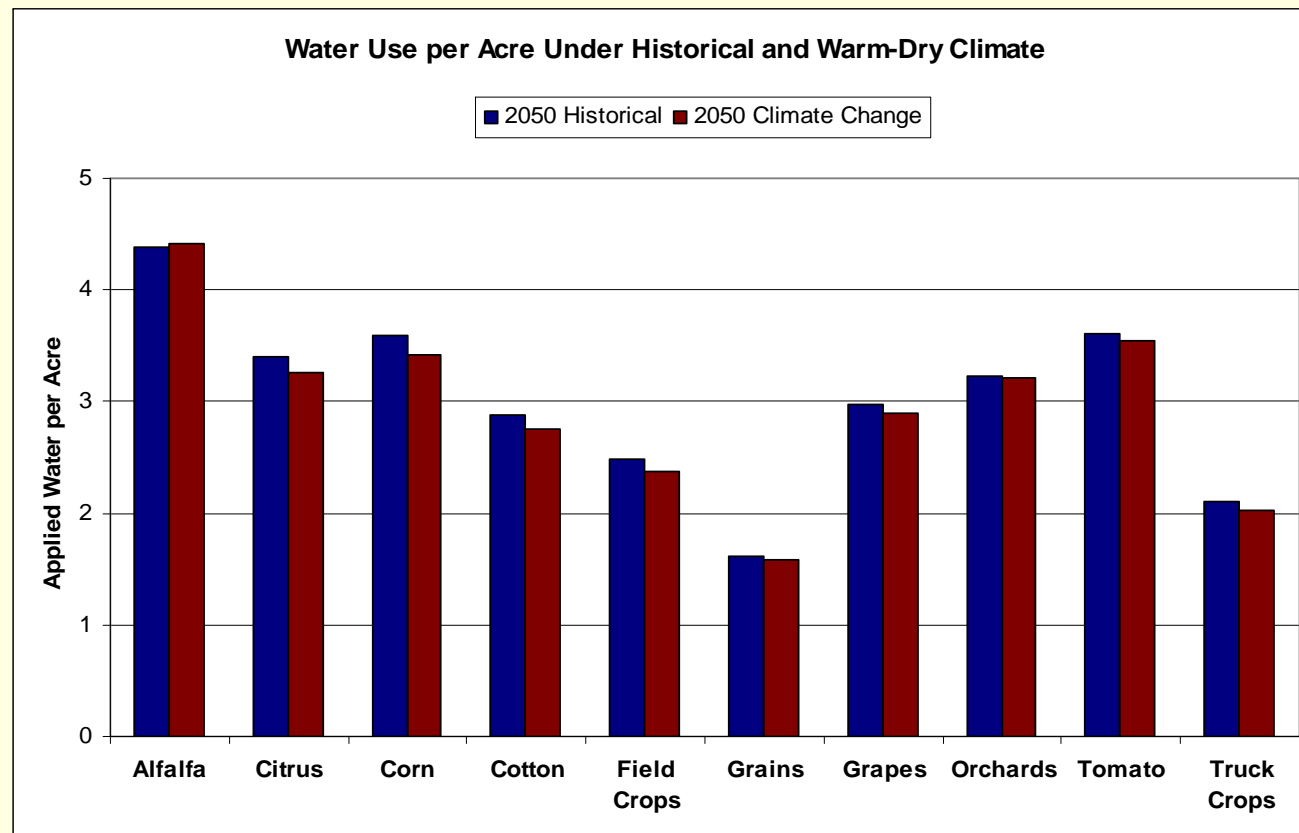■ % Change Price ■ % Change Production □ % Change Revenues

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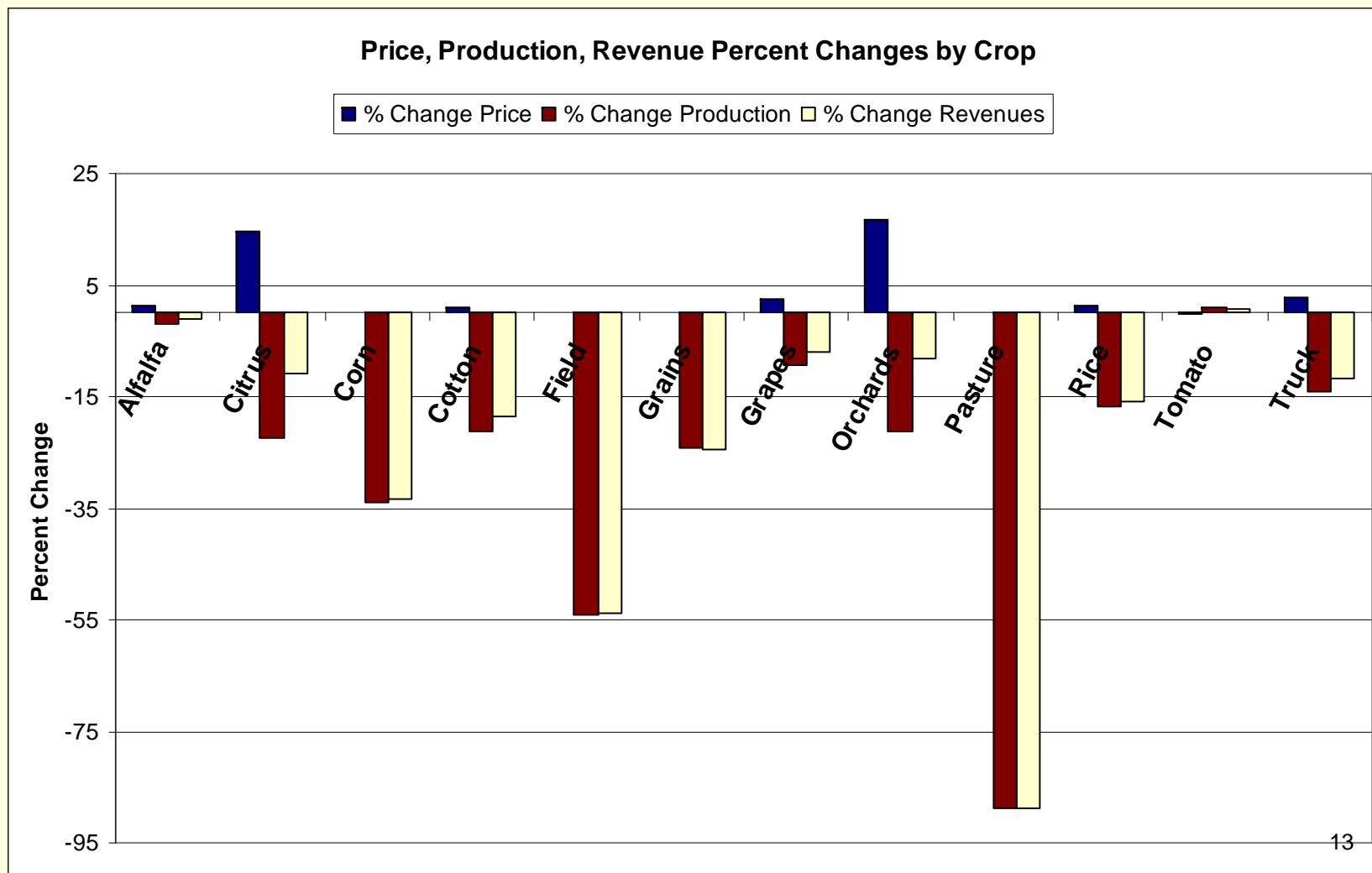
Extensive Margin Results: Regional Water Use

- Reduced water use across regions
  - Warm-dry climate water use from CALVIN allows for water transfers

Water Use Under Historical and Warm-Dry Climate

■ 2050 Historical ■ 2050 Climate Change

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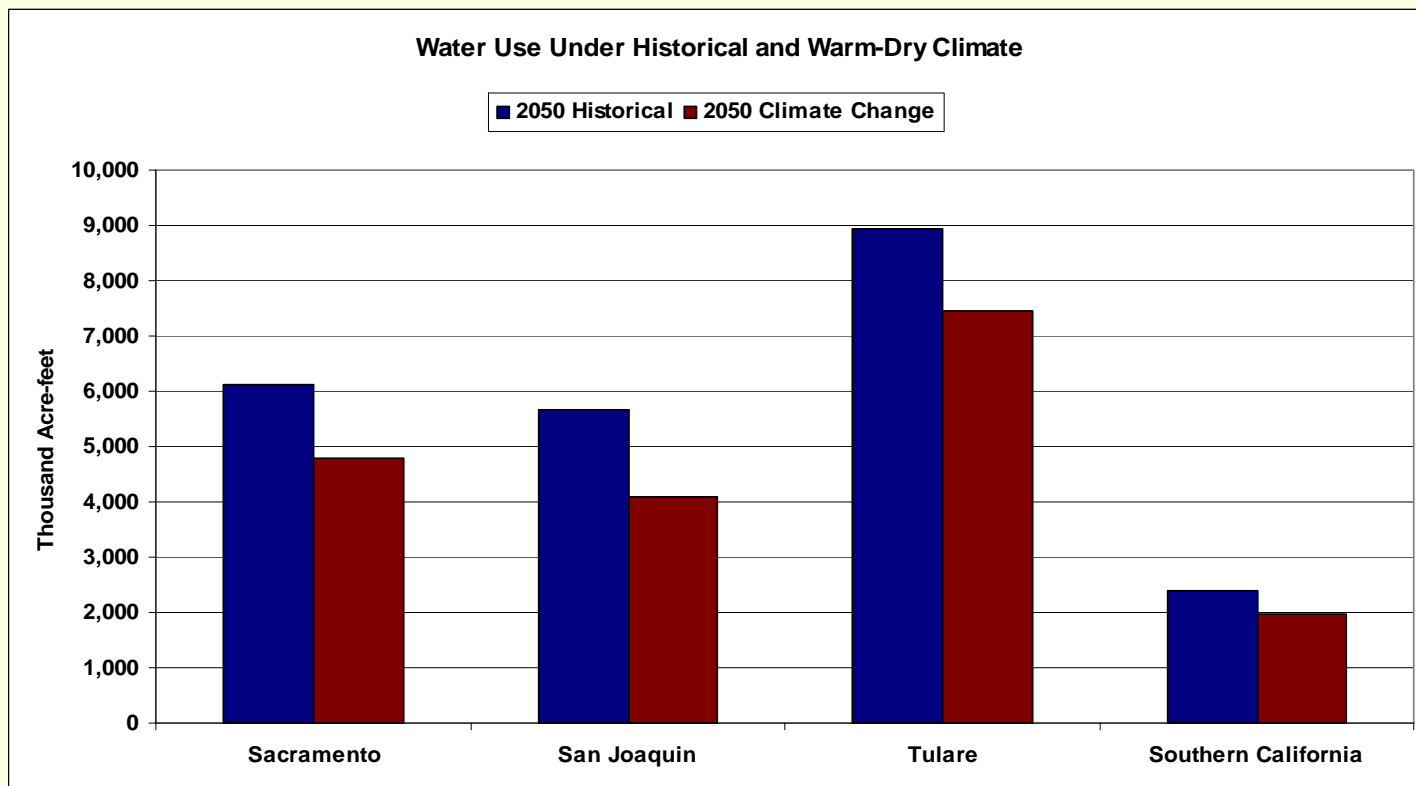
Intensive Margin Results: Water Use per Acre in CVPM 19

- Region 19 is in Kern County
- Farmers adjust water use per acre in response to reductions in available water and changing yields

Water Use per Acre Under Historical and Warm-Dry Climate

■ 2050 Historical   ■ 2050 Climate Change

Applied Water per Acre

Alfalfa · Citrus · Corn · Cotton · Field Crops · Grains · Grapes · Orchards · Tomato · Truck Crops

Extensions

- Current SWAP Updates
  - Include more regions
    - Update existing region boundaries
  - Include finer crop groups
  - Update production cost data
- More Accurate Water and Yield Data
  - Remote sensing
- Interdisciplinary teamwork is key to accurate modeling

Conclusions

- SWAP is useful for evaluating extensive and intensive margin adjustments
- Under climate change:
    - Statewide acreage reductions average 20.5%
    - Statewide revenue reductions average 12.4%
    - Shift away from water intensive crops
    - Crop price increases partially offset production decreases
    - Effects would be dampened with water markets

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Questions

Josue Medellin jmedellin@ucdavis.edu

Duncan MacEwan djmacewan@ucdavis.edu

http://cee.engr.ucdavis.edu/CALVIN